

Application of Extractive Fourier Transform Infrared Spectroscopy with Cryogenic Preconcentration: Preliminary Laboratory Results

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In collaboration with the Jefferson County Department of Health and the Environmental Protection Agency (EPA) Region IV, the University of Alabama in Huntsville recently developed a near-real-time trace gas monitor using extractive Fourier Transform Infrared Spectroscopy (FTIR) in concert with Extractive Cryocooled Inert Preconcentration (ECIP). The ECIP-FTIR uses a commercial FTIR spectrometer, a commercial long-path Infrared (IR) gas cell, a commercial acoustic Stirling cryocooler, and two custom parallel cryogen-free cryotrap to autonomously monitor an evolving multi-pollutant suite of volatile organic compounds. Every 15 minutes, the system records a trace gas absorption spectrum and the derived trace gas concentrations, using continuous non-preconcentrated sample flow through the gas cell, to achieve detection limits of ~ 10 parts per billion volume and a signal-to-noise ratio of $\sim 10^5$. Every 4 hours, the FTIR and gas cell obtain similar data on preconcentrated batch samples that have been thermally desorbed from the cryotrap, to improve detection limits to ~ 5 parts per trillion volume and improving the signal-to-noise ratio.

We present preliminary laboratory data collected at the National Space Science and Technology Center in Huntsville. These laboratory results show the ECIP-FTIR methodology is well suited for a wide range of trace gas research and monitoring applications, including EPA National Air Toxics Trends Stations and National Core monitoring network.

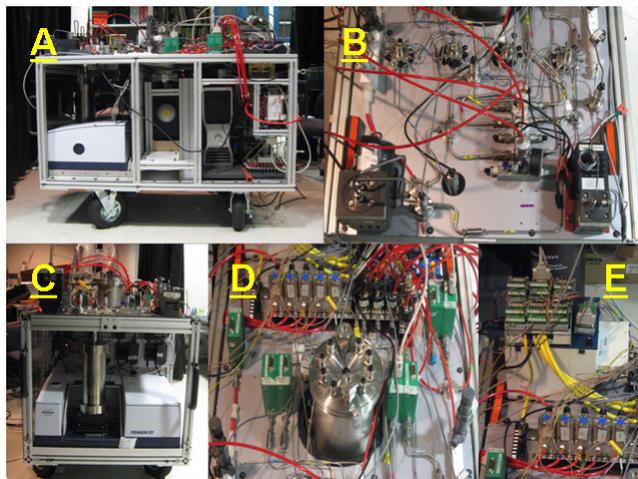


Figure 1. The ECIP-FTIR Instrument Layout. Panel A shows the entire instrument layout. From left to right, the FTIR, cryocooler, and electronics compartment with operations personal computer can be seen. Panel B shows the fluid subsystem including flow passages, inlet pumps, and shut off and flow selection valves. Panel C shows the optical subsystem with emphasis on the FTIR and gas cell. Panel D show the cryogenic subsystem and Quality Assurance/Quality Control manifold along with mass flow controllers (green boxes). Panel E shows the data acquisition system and mass flow junction boxes.

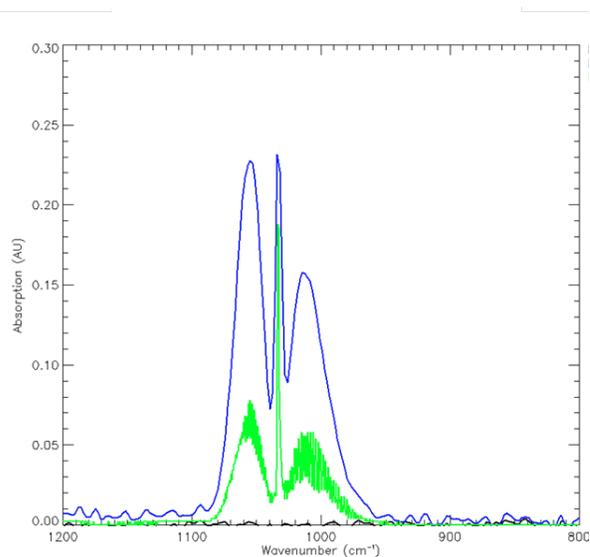


Figure 2. IR Spectrum of trace methanol in air taken at 1cm⁻¹ resolution and 15 minute co-addition. The blue trace is the measured methanol spectrum. The green trace is the deresolved library spectrum.